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ORIGINAL PAPER

Addressing awareness gaps in environmental valuation: choice experiments with citizens in the Inner Forth, Scotland

Anja Helena Liski[1] · Mark J. Koetse[2] · Marc J. Metzger[1]

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Abstract

Managed realignment of shorelines to manage floods and restore wetland can be difficult to implement without the support and involvement of local communities. Ecosystem service valuation tools, such as choice experiments, can be used to engage citizens in planning these sustainable transitions, yet citizens need to know their local shoreline and the pressures it is facing. Otherwise, people's ability to participate in local governance and to value potential changes is limited. The aim of this study is to identify and address awareness gaps that would hinder informed participation in a choice experiment: we address awareness gaps through deliberative interventions in a workshop setting, and by measuring the impact of deliberation through a comparison of choice experiment results performed before and after each stage of deliberation with citizens living on the shores of the Inner Forth estuary in Scotland. We estimate separate choice models for each of the choice experiments and find that deliberation increases both the resistance to 'status quo' and support for landscape-scale managed realignment of the shoreline. The deliberative interventions helped to identify clearer shoreline priorities and reduce contradictory patterns in shoreline preference. After gaining experience and deliberation, we find participants to become more selective: willingness to pay decreases substantially and model performance improves (slightly). Preferences diverge after learning about shoreline issues, whereas discussion converges preferences for the two most important shoreline attributes. These findings suggest that deliberative valuation not only shapes citizens' attitudes towards shoreline management but also improves the quality of citizen engagement in the delivery of sustainable transitions.

Keywords Ecosystem services valuation · Citizen participation · Managed realignment · Willingness to pay · Deliberative valuation

Introduction

Environmental valuation describes the values that individuals, groups or institutions hold for environmental features—such as water quality or biodiversity—with the aim of informing environmental decision-making, such as choosing between alternative land use options (Lienhoop et al. 2015). Stated preference techniques, such as choice experiments (Hanley et al. 1998), provide the tools for inviting citizens and other stakeholders to express their preferences with respect to possible or proposed policies. Whereas non-economist scholars have critiqued these techniques for the reductionist articulation of non-utilitarian (Lo and Spash 2013) and incommensurable (Vatn 2004) values, the internal critique of these approaches is concerned with the issues of preference discovery and knowledge gaps (Álvarez-Farizo and Hanley 2006; MacMillan et al. 2002). Since the 1990s, a new school of 'deliberative monetary valuation' (DMV) has emerged

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✉ Anja Helena Liski
anja.helena.liski@gmail.com

Mark J. Koetse
mark.koetse@vu.nl

Marc J. Metzger
marc.metzger@ed.ac.uk

[1] School of Geosciences, University of Edinburgh, Drummond Street, Edinburgh EH8 9XP, UK

[2] Institute for Environmental Studies (IVM), Vrije Universiteit Amsterdam, Amsterdam, Netherlands

(Jacobs 1997; Spash 2007) in response to these critiques to explore the role of deliberative processes in improving the outcomes of valuation.

We contribute to the DMV literature with a focus on the internal critiques of stated preference valuation. In particular, we explore the impacts of deliberation from both local and expert perspectives. Knowledge held by experts, such as researchers, can help citizens to understand how local areas are influenced by, for example, global changes (Anthony et al. 2009) or underlying ecosystem functions (Scarano 2006), or the extent to which an ecosystem is unique and irreplaceable (Le Saout et al. 2013). In contrast, local knowledge is often moral, qualitative and based on empirical observations, depicting the ecology and human uses of a specific area (Folke 2004). The literature suggests that scholars have not explicitly differentiated between local and expert knowledge in DMV studies.

There are various studies in which the emphasis has been on testing the impacts of expert-driven deliberation on willingness to pay. The findings have been mixed: Álvarez-Farizo and Hanley (2006), Bergstrom et al. (1990) and Robinson et al. (2008) found that preferences change due to deliberation, whereas MacMillan et al. (2006), Dietz et al. (2009), and Christie and Rayment (2012) do not find significant changes in preferences and willingness to pay (WTP). Christie et al. (2006) and Robinson et al. (2008) find that information and opportunities to discuss and ask questions improve the overall performance of the models estimated, and Shapansky et al. (2008) and Álvarez-Farizo and Hanley (2006) observe preference convergence within the group.

Local perspectives have been the focus of several deliberative environmental valuation studies (Álvarez-Farizo et al. 2007; Kenter et al. 2011; Völker and Lienhoop 2016; Kenter et al. 2016), which find discussion-based interventions to increase awareness of local knowledge and world views through social learning (Reed et al. 2010). Kenter et al. (2016) and Kenter (2016a) find that WTP estimates change after deliberations on local knowledge, whereas Lienhoop and Voelker (2016) do not observe statistically significant impacts on WTP. Kenter et al. (2011) find that many ecosystem services become priceless, as participants become unwilling to trade off attributes for monetary costs. Kenter (2016a) finds that WTP confidence intervals increase, as participants undergo systemic learning and better understand others' world views.

DMV offers an alternative participation format to the common fast-track formats of surveys or online questionnaires. Although they allow for both social learning through discussion (e.g. McCrum et al. 2009) and individual learning through repeated rounds of a choice experiment (Carlsson et al. 2012), the valuation outcomes are potentially affected by issues relating to group power dynamics (Turner et al. 2010) and diversity of views expressed (Völker and Lienhoop 2016). Recent DMV literature (Kenter 2016b; Irvine et al. 2016) advocate deliberative formats as a means to build consensus between participants. The DMV approach developed for our study does not explicitly focus on consensus-building, but it does potentially facilitate the formation of shared values and convergence of preferences because participants deliberate by learning *with* and *from* other participants (Vatn 2009). We find eight deliberative environmental valuation studies so far that compare workshops and interviews as valuation formats (Falk-Andersson et al. 2015; Lienhoop and MacMillan 2007; MacMillan et al. 2002; Kenter et al. 2016; Álvarez-Farizo and Hanley 2006; Christie et al. 2006; Lienhoop 2005; Shapansky et al. 2008). Kenter et al. (2016) and Lienhoop and MacMillan (2007) find WTP to be higher in workshop formats as participants have more time to familiarise themselves with unfamiliar ecosystems and ecosystem services. However, Álvarez-Farizo and Hanley (2006) and MacMillan et al. (2002) find WTP to be lower in workshops because participants take the payment aspect more seriously (MacMillan et al. 2002).

In our case study in the Inner Forth estuary in Scotland, we develop and test a deliberative framework for addressing awareness gaps in environmental valuation. Few studies (Bullock and Kay 1997; Álvarez-Farizo et al. 2007) so far have emphasised the importance of addressing awareness gaps in their method, explicitly diagnosing awareness gaps and designing the deliberative interventions to address these gaps. We take participants' awareness as the starting point to direct the design of deliberative interventions and measure their impact on participants' willingness to pay using a choice experiment. We incorporate expert knowledge in the valuation process under the ecosystem services and climate change frameworks. Local knowledge and views regarding the Inner Forth are brought into the valuation through discussion to share information about the area and reveal local attitudes and practices. We show that addressing participants' awareness gaps considerably changes their preferences and willingness to pay towards shoreline management measures.

The primary aim of this study is to develop a deliberative framework to address citizens' awareness gaps from both expert and local perspectives during environmental valuation. We then apply this framework to measure how participants' WTP for shoreline management measures changes after deliberative interventions in a workshop. The second aim is to measure the impact of the valuation format (face-to-face interview or workshop) on the elicited values. We hypothesise that the deliberative interventions affect WTP, as participants learn socially and individually during the choice tasks and deliberative interventions. However, it is a priori unclear which direction of change we should expect, because opposing effects of deliberation may be occurring at the same time. More specifically, increased awareness from deliberation may lead to higher WTP estimates (e.g. Lienhoop and MacMillan 2007),

while more participants may start to consider the monetary attribute in their choices, consequently leading to lower WTP estimates.[1] As discussed above, this is also confirmed by previous studies that find both increases and decreases in WTP estimates. We also hypothesise that the choice models perform better, as clearer preferences emerge, and that people's preferences to become more similar (i.e. converge). The impact of the interventions and the format is measured in WTP, and the process of deliberation is documented and reported qualitatively.

Methods

Inner Forth, Scotland

The shoreline of the Inner Forth, located in the central belt of Scotland (Fig. 1), mainly consists of reclaimed farmland, industrial brownfield, urban river edges and remnant stretches of tidal marsh and mudflats. The natural shoreline has been largely impacted by the seawalls that were built to drain intertidal flats for farming or industrial wasteland. The Inner Forth falls in four local municipalities, which poses further challenges for co-ordinated estuarine governance. The estuary is home to many communities that are amongst the most socially deprived in Scotland in terms of unemployment, low levels of education and high levels of crime (Scottish Government 2016). This study focuses on the residents living in (or near) the town of Alloa (Fig. 1). Access along the riverbanks is currently limited in many places due to poor condition or lack of paths, apart from the widely used roads between the historic harbours on its northern shore. If sea levels rise at rates according to the central estimates of the medium emissions scenario, which is a relatively conservative estimate given the observed rates in the Firth of Forth in the recent decades (Rennie and Hansom 2011), relative sea levels could rise by 24 cm by 2080 compared to 1990 levels (UK Climate Projections 2009). The changing climate is expected to increase the vulnerability of infrastructure, communities and wildlife by increasing flooding and storm events. Low lying areas may become inundated and agriculturally unproductive, unless adaptation measures are adopted.

Local stakeholders involved in shoreline management are investigating the possibility of realigning the river edge landward, a technique known as managed realignment, which has been proposed as an economically and environmentally sustainable option for climate change adaptation in the UK (Turner et al. 2007; Luisetti et al. 2011). Managed realignment would lead to the restoration of tidal marshes and flats in the area (Wolters et al. 2005) and create more space to absorb excess water during storm event, potentially limiting the damage to built infrastructure elsewhere in the basin. Furthermore, many of the existing tidal areas are in poor ecological status, which could be alleviated by undertaking active conservation measures. Local ecologists estimate that restoration and enhancement activities could lead to considerable increases in numbers of breeding wildfowl and waders.

Scoping phase

The scoping phase consisted of three activities (Fig. 2). First, we identified awareness gaps in relevant topics (shoreline biodiversity, ecosystem services and climate change) that would make it difficult for the participants to make informed choices, by interviewing 53 citizens for 5 min to 1 h over four consecutive days in June–August 2015. We employed a quantitative survey involving scoring procedures of statements and different ecosystem services to assess awareness and priorities of participants. If time allowed, we continued with an open-ended interview.

Furthermore, we carried out two pilot studies in Alloa to support the design of the choice experiment. The purpose of the first pilot was to test and improve the clarity of choice tasks, and to determine appropriate levels for the monetary attribute ($n = 17$, Online Resource 1). During the second pilot, a sample of citizens completed a choice experiment, which provided us with information on which choice situations to include in the main choice experiment ($n = 25$).

Main study

For the main study, we organised five workshops for 109 participants in total in Alloa Town Hall on Saturdays between October 2015 and February 2016 and interviewed 98 people face-to-face in Alloa between November 2015 and August 2016 (with separate samples for workshop and interviews). None of the participants were included in the scoping phase. The face-to-face interview participants took part in a single-stage choice experiment, whereas in the workshop, the choice experiment was implemented at three distinct stages in the workshop process, specifically before and after both deliberative interventions. All participants in both workshops and interviews were given the same information before completing the task (Online Resource 1), filled in a background questionnaire before the choice experiment (Online Resource 2) and completed a follow-up questionnaire to gauge which attributes and who (myself, family, community) they considered when making their choices. Workshop participants were also asked whether their preferences and choice certainty had changed during the workshop (Online Resource 1).

[1] This phenomenon of attribute non-attendance, in which participants pay unequal amounts of attention to different attributes in choice experiments, has recently received considerable attention in economics (e.g. Koetse 2017; Campbell et al. 2011)

Fig. 1 The Inner Forth is the inner section of the Firth of Forth estuary. The areas highlighted in blue indicate where the shoreline could be realigned or degraded wetlands could be enhanced. The workshops were organised in the town of Alloa

The workshops and interviews differ in terms of the time invested, travel effort, social dynamic and compensation. Workshop participants give up several hours of their day and travel to a local venue, whereas interview participants only spend 10–15 min completing their task. In the workshops, choice tasks are completed individually but in a group setting. All workshop participants were paid £40 at the end of the event to compensate for their efforts and time and to attract demographic groups who may not otherwise attend.

Recruitment of participants

The majority of participants live within 1–5 km from the river Forth, primarily in Clackmannanshire. Focusing on residents from one area instead of the entire region limits the variability in preferences because respondents have a similar if not identical geographical reference point, making it easier to interpret changes in WTP due to deliberative interventions. Participants were directly approached on busy pedestrian areas in Alloa (Fig. 1) and invited to take part in an interview or workshop. Individuals who were invited to the workshop were encouraged to bring a friend or family member if that would make them feel more comfortable to attend.

Workshops

In the beginning of the workshop, the lead researcher explained the purpose and aims of the event to all workshop participants in plenary (Online Resource 2).

Choice experiment design The design used for the main study is a D-efficient statistical design, generated in NGene (version 1.1.1). The information (parameter priors) that are required for generating this type of design were obtained from the choice experiment that was performed during the second pilot study. The statistical design consists of four different sets of choice

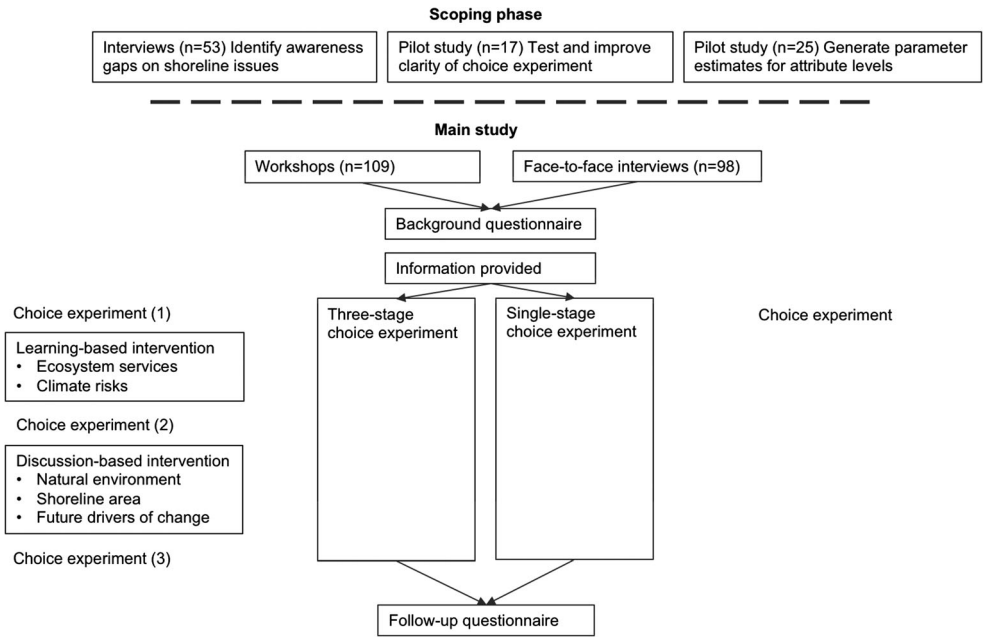

Fig. 2 An overview of the methodology. The scoping phase informed the design of the choice experiment (workshops and face-to-face interviews) and the deliberative interventions (workshops only)

cards, with six cards in each set. A different set was assigned to each of the first four events. Because the first event was undersubscribed, the same set of choice cards was used in the fifth event. The workshop participants completed the same set of choice cards at all three stages in the workshop, but the order of cards and options in each card were shuffled to avoid a sense of repetition.

Each choice card has three shoreline options (Fig. 3). One out of the three options is the status quo, and the two remaining options involve changes in terms of both the shoreline attributes and the monetary attribute. There are three shoreline attributes that were chosen based on the findings of the scoping phase (Online Resource 1):

– Managed realignment (salt marsh and mudflat habitats are restored through landward retreat of artificial flood defences, resulting in losses of farmland and industrial wasteland)

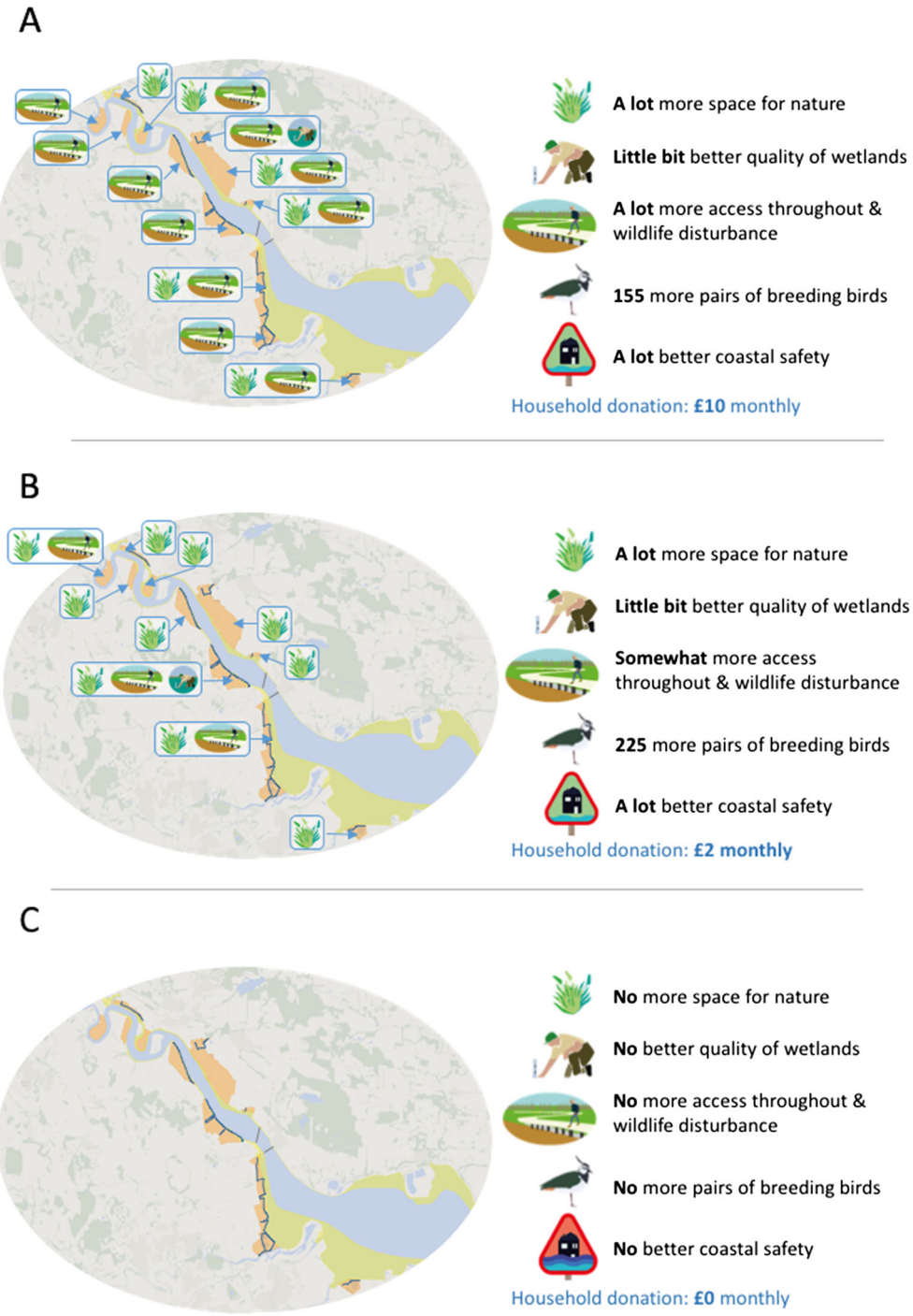

Fig. 3 Example of a choice card presented to the participants

- Conservation actions (rangers actively manage degraded tidal habitats by e.g. installing sluices and raising water tables)
- Recreational paths (walking and cycling routes are maintained where paths are in poor state, and created where there are no existing paths)

The monetary attribute is a monthly donation (of £2, £3, £5, £7 or £10) during a period of 5 years to the Inner Forth Landscape Initiative, which implements landscape improvement projects, including habitat restoration, in the area. A donation-based attribute was selected instead of a tax-based attribute. Although this may decrease incentive compatibility (e.g. Johnston et al. 2017), using tax as a payment vehicle was tested during the first pilot study and found to be inappropriate, mainly because of high unemployment figures in the region. In the choice experiment, the changes in the shoreline attributes occur in terms of magnitude of change and in terms of distance from Alloa. We distinguish four levels for each attribute: short distance, long-distance, medium and maximum level. The magnitude of change is low in the short-distance and long-distance attributes, medium in the 'medium' level, and high in the 'maximum' level. The distance from Alloa is short for 'short-distance' level, long for 'long-distance' level, whereas in medium and maximum, there are sites at short and long distances. The levels are represented by a set of shoreline land parcels, where the shoreline attribute in question would change:

- Short distance
- Land parcels only near resident areas of Clackmannanshire
- Long distance: Randomly selected combination of an equivalent number of land parcels that are far away from the resident areas (to assess the impact of distance on preference)
- Medium: Changes occur in twice as many land parcels as in 'long distance' and 'short distance', with half of the parcels nearby and half of the parcels far away.
- Maximum: Changes occur in all feasible land parcels. The exact number of sites for this level varies somewhat between attributes, depending on the number of sites where the attribute actually can change

Deliberative interventions The first 'learning-based' deliberative intervention was a 15-min presentation focusing on scientific evidence regarding shoreline issues. The content of the talk (Online Resource 2) was identical and delivered by the same team member in all workshops. Participants were given limited opportunity to ask questions during or after the intervention. Instead, the presenter followed up questions on an individual basis to avoid vocal or engaged individuals influencing other participants' perception of the learning-based intervention.

The second 'discussion-based' intervention facilitated knowledge sharing on local uses and understandings of the shoreline. It was implemented in groups of three to seven people and led by a team of facilitators who took part in a training session before the workshops. Groups discussed the natural environment in their local area, the implications of managed realignment of the local shoreline, and potential future drivers of change that would impact the shoreline (Online Resource 2). Here we only analyse the final part of the discussion because it emerged to be most reflective of participants' awareness of shoreline issues. We assigned codes to the drivers of change mentioned based on the social-ecological systems (SES) framework (Ostrom 2007), to determine which SES variables received most attention during the intervention. A detailed description of this SES analysis is in Online Resource 3.

Choice model estimation To measure the impact of the deliberative interventions, we estimate three separate random parameter logit (RPL) models (Train 2009) using NLOGIT 5 software, corresponding to the three stages during the workshops. Applications of RPL models have shown that this model is superior to the standard multinomial logit (MNL) model in terms of overall fit and accuracy of welfare estimates (e.g. Provencher and Bishop 2004). RPL models account for preference variability and repeated choices (Train 2009) and allow for deriving both mean WTP and WTP variance across individuals, giving us the opportunity to compare the impact of deliberative interventions on the entire WTP distribution. However, we also estimate MNL models to triangulate the analysis for the pattern of preferences. In the models, the choices made during in the choice experiments are used as the dependent variable, and the choice attribute levels are used as independent variables. We dummy-coded the attribute levels in the model and used the 'short distance' attribute level as the reference point. We include random parameters for all attribute levels, except for the monetary attribute, for ease of mean welfare calculations and because this is known to substantially inflate the variation in value estimates (e.g. Hensher et al. 2005; Daly et al. 2012; Hess et al. 2017). In order to assess robustness of our findings to this assumption, we also estimated RPL models with a random donation parameter using a triangular distribution restricted to the negative domain; patterns in the effects of the workshop interventions on welfare estimates do not change, and model performance (measured by adjusted pseudo R^2) only increases very slightly. For each attribute level, we draw 1000 times from a uniform distribution using Halton draws. WTP and WTP standard errors were obtained using the Krinsky and Robb (1986) method, using mean parameters only and using 10,000 draws. We applied the Poe test (Poe and Giraud 2005) to compare the

mean WTP estimates, and the Mann–Whitney test (Mann and Whitney 1947) to compare the WTP distributions between formats and deliberative interventions.

Face-to-face interviews

To measure the impact of the valuation format on participants' preferences, we implemented the same choice experiment using a standard face-to-face interview approach. The interview participants were randomly assigned to one of the four choice card sets. We measured the impact of the valuation format by estimating a fourth RPL model and by comparing the results with the RPL estimates for the first stage of the workshop choice experiment.

Results

Scoping phase: identifying awareness gaps

Many of the scoping phase participants held rich local knowledge, built on a life-long experiences living by the Forth: "The river Forth has always been part of my life. It should be cared for and looked after". For others, the connection was less personal and they had less local knowledge regarding the river, but nevertheless often expressed a sense of responsibility for protecting local wildlife: "I am aware that there are wetlands but I'm not sure where they are. They are definitely important, poor birds have flown thousands of miles". The latter quote represents many of those that were interviewed who had little local knowledge of the shoreline areas. Many were not even aware that there are habitats for birds (22%) and fish (32%); however, 93% and 86% (respectively) agreed it was important to have habitats for wildlife in the local tidal areas. Many people were not aware that tidal marshes and flats reduce erosion (38%) and regulate flooding (32%), but most participants agreed that they are locally important ecosystem services (83% and 93%, respectively).

Valuation phase: addressing awareness gaps and measuring impact

Altogether, 109 people participated in the workshops and 98 in the face-to-face interviews during the valuation phase. Out of those who were approached with an invitation to participate, 7% took part in the workshops and 28% in face-to-face interviews. The population samples for both formats were representative of the Clackmannanshire population, although face-to-face interview participants were somewhat more representative in terms of household ownership, age and employment (Online Resource 4). About 35% of workshop and 40% of interview participants live in areas that fall within the 20% most deprived areas in Scotland (Scottish Government 2016).

Deliberative interventions

Although participants demonstrated broad awareness of how different local activities (e.g. housing development) impact the river system and local capacity to cope and adapt to changes, there was relatively less discussion on the dependencies of and impacts on the natural environment (Online Resource 3). There was a wide recognition that climate change would impact flood risk (Online Resource 3), which is unsurprising given that this task was performed after the learning-based intervention. Fracking (raised by all 20 groups) and climate change (18 groups) were the priority concerns amongst the participants.

Estimation results and mean willingness-to-pay estimates

The dependent variables in our models are the choices made by respondents in the choice experiment. We present the RPL model estimates and mean WTP estimates for the separate formats and stages in Table 1.

We find substantial differences in performance of the models, especially between the model for the face-to-face choice experiment and the models for workshop choice experiments. The adjusted McFadden pseudo R^2 values are 0.19 for the face-to-face interviews, 0.40 before interventions in workshops, 0.44 after the learning-based intervention and 0.41 after both interventions (Table 1), which are good values for a choice model (Louviere et al. 2000).[2]

Our findings furthermore show that the choice experiment format (face-to-face versus workshop) and our learning-based and discussion-based interventions substantially and significantly affect WTP estimates. The Poe and Giraud (2005) and Mann and Whitney (1947) results are reported in Online Resource 5. There is a statistically significant difference in mean and distribution of WTP between formats (interview and workshop) for all attribute levels ($p < 0.05$), except the mean WTP for long-distance and medium conservation actions and long-distance recreational paths. The difference is significant ($p < 0.05$) also after the learning-based intervention for all attribute levels except the mean WTP for maximum recreational paths. After the discussion-based intervention, the mean and distribution of WTP estimates are significantly different from the estimates after the learning-based intervention for all attribute levels ($p < 0.05$).

We also find that the number of statistically significant attribute coefficients in our models decreases, especially after our workshop interventions. In the model for the face-to-face choice experiment, and the model for the workshop choice

[2] For robustness, we also estimated more simplistics MNL models. Although not explicitly reported here, we find that these MNL models do not perform nearly as well in terms of model performance, but that their estimates display very similar preference and WTP patterns as our RPL estimates.

Table 1 Random parameter logit estimates for choice in face-to-face interviews and workshops. The reference category is the short-distance option for all attributes. Standard errors of coefficients (S.E.) are in parentheses. Significant relationships between utility and choice (coeff.) and significance of variability (st. dev.) and mean willingness to pay (MWTP) are indicated for 1% (***), 5% (**) and 10% (*) significance levels

		Face-to-face interviews			Workshops								
					Before interventions			After learning-based interv.			After both interventions		
Attribute	Level	Coeff. (S.E.)	St. dev. (S.E.)	MWTP (S.E.)	Coeff. (S.E.)	St. dev. (S.E.)	MWTP (S.E.)	Coeff. (S.E.)	St. dev. (S.E.)	MWTP (S.E.)	Coeff. (S.E.)	St. dev. (S.E.)	MWTP (S.E.)
Status quo	–	1.010 (0.927)	4.045*** (0.584)	£15.6 (968)	−2.582* (1.319)	7.971*** (1.196)	−£9.12** (4.421)	−9.742*** (3.022)	17.155*** (3.870)	−£22.6*** (7.558)	−10.591*** (2.965)	13.237*** (3.171)	−£21.2*** (4.405)
Managed realignment	Long dist.	0.893*** (0.342)	0.912 (0.564)	£14.5 (510)	0.761** (0.381)	0.020 (0.629)	£3.29 (2.546)	0.161 (0.410)	0.046 (1.254)	£0.74 (1.987)	−0.612 (0.432)	1.498* (0.768)	−£1.80 (1.144)
	Med.	1.435*** (0.378)	1.063* (0.552)	£23.7 (815)	2.079*** (0.445)	0.015 (0.532)	£8.91** (3.734)	1.483*** (0.449)	0.058 (0.684)	£5.80* (3.002)	0.826* (0.439)	0.309 (1.537)	£2.41 (1.631)
	Max.	1.874*** (0.397)	0.438 (0.652)	£30.6 (1057)	2.359*** (0.457)	1.111 (0.726)	£10.0*** (4.116)	2.345*** (0.509)	1.733** (0.725)	£9.16** (3.817)	1.437*** (0.445)	0.864 (0.975)	£4.17** (1.873)
Conservation actions	Long dist.	0.425 (0.385)	1.761*** (0.535)	£7.62 (376)	1.069** (0.436)	0.265 (0.871)	£4.56 (3.058)	0.850* (0.484)	0.135 (0.866)	£3.33 (2.834)	−0.584 (0.459)	0.104 (0.867)	−£1.64 (1.257)
	Med.	0.796** (0.370)	0.710 (0.594)	£13.6 (568)	1.465*** (0.435)	0.101 (0.562)	£6.28* (3.279)	1.093** (0.486)	0.117 (0.943)	£4.30 (2.895)	−0.229 (0.455)	0.017 (1.376)	−£0.54 (1.376)
	Max.	1.259*** (0.362)	0.400 (0.784)	£20.9 (787)	2.039*** (0.448)	0.852 (0.952)	£8.72** (3.787)	2.077*** (0.538)	1.907*** (0.713)	£8.07** (3.737)	0.528 (0.471)	1.596** (0.714)	£1.55 (1.659)
Recreational paths	Long dist.	0.451 (0.394)	0.892 (0.797)	£7.82 (353)	0.601 (0.460)	1.666** (0.654)	£2.59 (2.803)	0.557 (0.511)	0.732 (1.087)	£2.21 (2.706)	−0.227 (0.476)	1.435* (0.792)	−£0.62 (1.445)
	Med.	0.627* (0.334)	0.471 (1.184)	£10.4 (453)	0.431 (0.351)	1.019 (0.755)	£1.97 (2.031)	0.054 (0.378)	1.457** (0.656)	£0.34 (1.731)	−0.790** (0.398)	1.661** (0.742)	−£2.21** (1.015)
	Max.	0.815** (0.342)	0.543 (0.855)	£13.4 (502)	0.507 (0.364)	1.184* (0.684)	£2.29 (2.224)	0.835* (0.430)	1.646** (0.665)	£3.37 (2.571)	−0.140 (0.420)	2.094*** (0.663)	−£0.39 (1.289)
Donation	–	−0.061 (0.040)	–	–	−0.241*** (0.051)	–	–	−0.264*** (0.057)	–	–	−0.347*** (0.065)	–	–
Adj. pseudo R^2		0.19			0.40			0.44			0.41		
Log likelihood		−492.36			−414.41			−398.93			−421.63		
Participants		98			109			109			109		
Number of observations		551			633			645			647		

experiment before interventions, there are seven statistically significant ($p < 0.05$) attribute coefficients; after the learning-based deliberation, there are six statistically significant attribute coefficients ($p < 0.05$); and after both interventions, there are only four statistically significant ($p < 0.05$) attribute coefficients left (see Table 1). Altogether, 40% and 24% of the workshop and interview participants (respectively) stated that they had considered the donation when making their choices, amongst those who were asked (100% were asked in workshops, and 95% in interviews). This observed non-sensitivity to the donation attribute could in principle be due to the range of attribute levels being too low to be of interest. However, this is unlikely because the range of donations was explicitly tested and determined in a pilot study. Donation (65%) and an overall impression of shoreline attributes (47%) were the most common motivations that participants stated to have determined their choices in the face-to-face interviews (Online Resource 6). Altogether, 82% considered themselves when making a choice, 68% their family and 75% the community.

Effects of the valuation format on willingness to pay and estimation results

We find the mean WTP estimates to be significantly lower in the workshop before interventions than in the face-to-face interviews for all levels of managed realignment, 'maximum conservation actions' and medium and maximum recreational paths ($p < 0.05$, Online Resource 5). The differences in donation coefficients between the formats, but especially the fact that the donation coefficient for the face-to-face experiment is not significant, suggest that it is not sensible to compare the WTP estimates between the face-to-face and the workshop format. In Fig. 4, we have therefore only included WTP distribution curves from the three workshop choice experiments.

Effects of deliberative interventions on willingness to pay and choice certainty

After learning-based intervention, we find that WTP estimates decrease significantly for all attributes, except for 'maximum recreational paths' (Table 1). After both interventions, WTP estimates are substantially lower for all attributes, except for the status quo. Altogether, 47% felt more certain about their choices after the deliberative interventions, whereas 9% felt less certain, and 44% did not think their certainty had changed. In total, 36% felt that having more experience in making choices had affected their certainty, 35% because they had learned about others' opinions, 19% because of mapping and discussing landscape values and 50% for learning more about the shoreline areas. Overall, 35% felt that all deliberative activities had shaped their preferences, 36% felt that one of two had had an impact and 29% felt that there had not been an impact.

The status quo shoreline

We find a positive but statistically insignificant relationship for status quo in the face-to-face interviews and negative statistically significant coefficients at all stages of the workshop. After each intervention, the negative impact of the status quo option increases, implying that people are increasingly moving away from choosing the status quo. The changes in WTP distribution curves (Fig. 4) and standard deviations of the random parameters (Online Resource 5) show that preference variability increases after the learning-based intervention ($p < 0.01$) and decreases after the discussion-based intervention ($p < 0.01$).

Managed realignment of the shoreline

Respondents are significantly ($p < 0.05$) more likely to choose 'maximum managed realignment' over the short-distance option in both formats (Table 1). The 'maximum managed realignment' is the highest ranked attribute level in both interviews and workshops, suggesting it was the most preferred attribute. Participants in both interviews and workshops before the interventions prefer sites further away instead of nearby ($p < 0.05$). After the interventions, this pattern shifts to a positive but insignificant preference for short distance. Preference variability increases for all levels after the learning-based interventions (Fig. 4).

Conservation actions on the shoreline

Interview participants do not have a significant preference in terms of distance to conservation actions (Table 1). In workshops, there is a preference ($p < 0.05$) for conservation actions to occur further away before the interventions; however, after the interventions, the difference is not significant. Participants in the interviews and workshops are significantly ($p < 0.05$) more likely to choose the medium and maximum level over the short-distance option; however, after discussion-based interventions, this relationship is no longer significant.

Recreational shoreline paths

Face-to-face interview participants prefer more paths (at maximum level) over fewer paths ($p < 0.05$), whereas workshop participants do not have a preference for having more paths (Table 1). After both interventions, however, they prefer fewer recreational paths, but only at the medium level ($p < 0.05$). Overall, the deliberative interventions increase preference variability for paths, particularly the discussion-based intervention (Fig. 4).

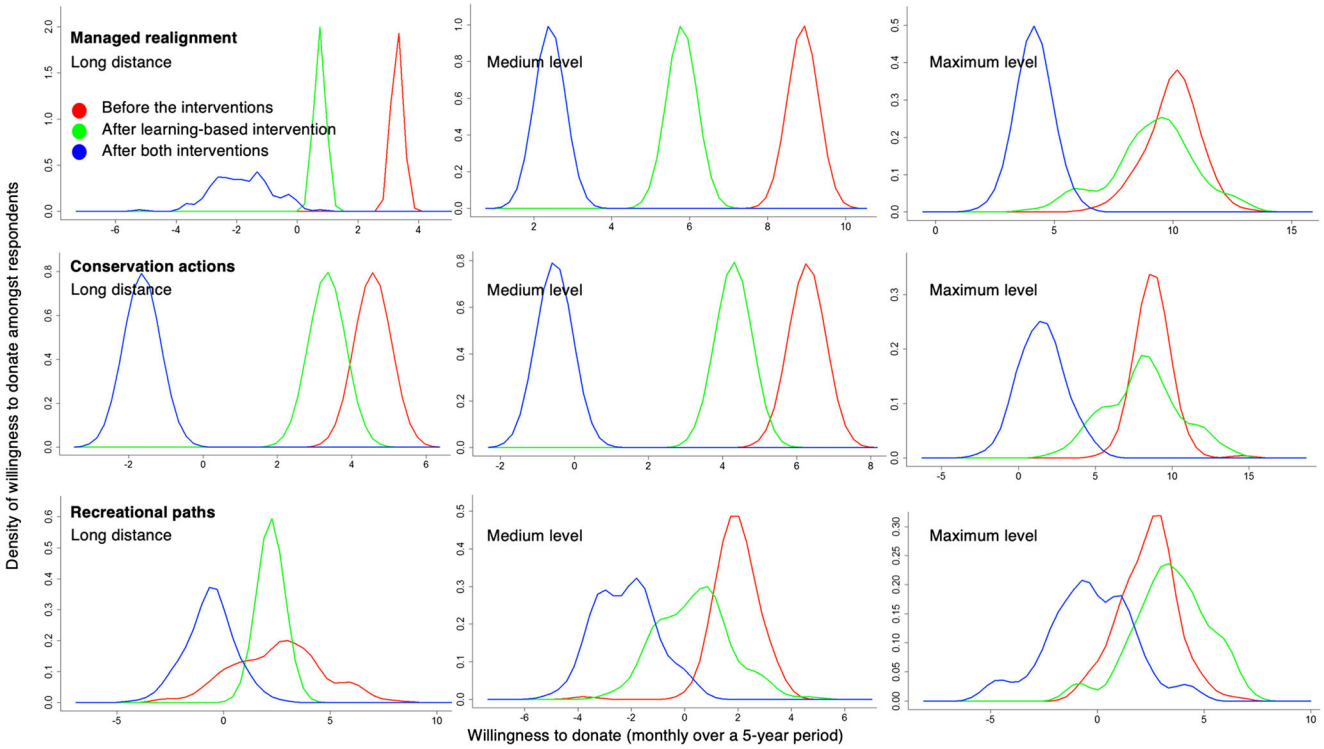

Fig. 4 Distribution of willingness to pay in the workshops derived from the random parameter logit model outputs. With the curves being the density functions of willingness to pay, the *y*-axis represents the height of the density function. The intervals at which willingness to pay is estimated on the *x*-axis have been adjusted differently for each sub-figure to improve display of the relative difference in distribution between the three stages. The intervals at which willingness to pay is estimated on the *x*-axis are as follows: top left 0.2, top middle 0.4, top right 0.6; centre left 0.5, centre middle 0.5, centre right 0.8; bottom left 0.6, bottom middle 0.5, bottom right 0.6

Discussion

Sustainable transitions, such as managed realignment of shorelines to manage floods and restore wetland, can be difficult to implement without the support and involvement of local communities (Richardson and Razzaque 2006). In the case of the Inner Forth, our results show that there is considerable support for managed realignment, suggesting that engaging representative groups of citizens in shoreline management would potentially support the uptake of nature-based adaptation options. The fact that 109 citizens were willing to spend several hours of their day to learn and discuss local environmental issues shows that there is public interest for increased participation in shoreline management, particularly if citizens are compensated for their time and efforts. However, as evidence presented here and by others (Roca and Villares 2012; Myatt-Bell et al. 2002) shows, citizens know little about the pressures their local areas are facing, limiting their ability to make informed choices in participatory valuation. Furthermore, engaging citizens from even the most socially deprived areas is often difficult (Ferragina et al. 2013). We succeeded in this through a high-effort face-to-face recruitment technique and by paying the participants for their efforts and time.

Our first finding is that WTP estimates are affected substantially and that WTP decreases for all attribute levels after both deliberative interventions, in line with findings by MacMillan et al. (2002). It remains unclear why WTP decreases: participants potentially consider more carefully how the shoreline attributes weigh up against the donation involved or overstate their WTP less after deliberation (Shogren 2006; MacMillan et al. 2002). Yet, resistance to maintaining the status quo shoreline increases after both interventions. This observation, together with the self-reporting of the majority (71%) of participants who felt that (at least one of) the interventions had shaped their preferences, suggests that deliberation shaped people's attitudes towards shoreline management.

Our second finding is that the deliberative interventions lead to the emergence of clearer priorities: after deliberations, maximum managed realignment is notably more important than the other shoreline attributes, and magnitude of change stands out to be more important than distance to sites. We find that the number of other statistically significant attribute levels decreases, contrasting the findings of Christie et al. (2006) and Dietz et al. (2009) who observe an increase in the number of statistically significant attributes. The reduction in significant attribute level parameters could be considered to reduce the

validity of the choice model, although it is a priori unclear whether the number of significant parameters should increase or decrease after learning. Moreover, there is an (admittedly limited) increase in model fit (Table 1), and an increase in the self-reported confidence in making choices, although this subjective assessment mode may be burdened with for example social desirability bias (Fisher and Katz 1999).

A limitation of our study is that we do not experimentally isolate the effects of the two deliberative interventions from the individual learning effect emerging from simply repeating the same choice tasks. Using a split sample design with control treatments would have allowed us to measure the relative importance of both individual and social learning. We do argue that changes in relative preferences and WTP estimates over the three workshop stages are (far) more substantial than the effects of repetitive learning and preference discovery reported in the literature (e.g. Bateman et al. 2008), if such effects are present at all (e.g. Brouwer et al. 2010). Still, individual learning through repetition may have an effect on our results, so we draw tentative conclusions about the extent to which the observed impacts are caused specifically by our deliberative interventions.

For the learning-based intervention, we find preferences to diverge for all significant attribute levels, suggesting that participants responded to and digested the information in different ways. We did not give the participants an opportunity to discuss the information given in the learning-based intervention before the second choice task, which potentially hindered some participants' ability to reflect and digest the information. If this is the case, it is not surprising that only 50% of participants (whose confidence increased) felt that the presentation had played a role in improving their confidence. Despite this limitation, the intervention reduced inconsistencies in preferences: for example, participants no longer wanted preferable attributes to occur further away from their homes (in fact, distance becomes an insignificant factor in determining choices). 'Analytic-deliberative' approaches, which allow time for participants to reflect together on the scientific evidence (Stern and Fineberg 1996; Renn and Schweizer 2009), are potentially more suited for consensus-building than the approach taken here, or the two approaches may even be complementary.

For the discussion-based intervention, we find a significant impact on preference variability for all attribute levels, however, there is no clear pattern in terms of the direction of the impact. For the two most important attributes preferences appear to converge, i.e. resist the status quo shoreline and prefer the maximum managed realignment (Table 1). This is somewhat consistent with the premise outlined above that discussion-based deliberation supports the formation of clearer priorities. More broadly, the discussion-based deliberation was relatively more important than the learning-based intervention in shaping participants' preferences in terms of magnitude of change. The discussions also complemented the learning-based interventions by highlighting issues that had not been mentioned before (e.g. pressures from housing, fracking and pollution; Online Resource 3). These findings therefore provide support for the claim by scholars to advance deliberative methods that achieve integration of different knowledge types (e.g. Raymond et al. 2010; Huntington et al. 2002; Olsson and Folke 2001).

Conclusions

In this study, we asked whether addressing awareness gaps from both local and expert perspectives affects people's stated willingness to pay towards shoreline changes in the Inner Forth. We find that WTP for regulating and cultural ecosystem services is significantly lower after the deliberative interventions; however, there is still considerable support and WTP for managed realignment in the Inner Forth. We introduce evidence of how DMV not only improves the quality of participation and analysis (improved model fit and confidence in making choices) but also shapes and builds citizens' attitudes towards the policy question (emergence of clearer priorities and resistance to the status quo shoreline). Our findings highlight the importance of explicitly addressing awareness gaps in deliberative formats of participatory tools to achieve high-quality engagement of citizens and other stakeholders in sustainable transitions at the local level.

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Compliance with ethical standards

We obtained informed consent from all participants, and adequately handled their confidentiality, in line with the School of Geosciences (University of Edinburgh) Research Ethics Procedure. The research plan was reviewed and approved by the School of Geosciences Ethics Committee prior to the fieldwork, and permission was obtained for photography and filming.

Conflict of interest The authors declare that they have no conflict of interest.

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